

## TRANSPORTING HAZARDOUS MATERIAL

### Purpose:

This lesson introduces students to general considerations used to select routes for highway transportation of hazardous materials. Students explore the complexities of hazardous materials transportation route selection and simulate selection of highway routes in their home State.

### Concepts:

1. Transportation of hazardous materials requires special safety considerations.
2. Many factors are considered in selecting routes for highway shipments of hazardous materials, including spent fuel.

### Duration of Lesson:

Two 50-minute class periods

### Objectives:

As a result of this lesson, the learner will be able to:

1. read and use a State highway map;
2. identify interstate and State highways and secondary routes in his/her State;
3. interpret the map legend;
4. calculate mileage estimates using both the mileage chart and the mileage numbers on the map;
5. distinguish between cities of various sizes on the map;
6. identify the Federal, State, and local agencies responsible for the safe transportation of nuclear waste;
7. identify general criteria considered in selecting routes for highway transportation of hazardous materials; and
8. select potential highway transportation routes into and through his/her State, using existing criteria.

### Skills:

Critical thinking, discussing, map reading, simulation, working in groups

### Vocabulary:

Interstate, interstate bypass, scale

### Materials:

Activity Sheets

*Analyzing State Highway Maps*, p. 171

*Planning an Alternative Hazardous Materials Shipment Route*, p. 175

Other

State highway maps

**Suggested Procedure:**

1. Have students read the introduction to the activity entitled *Analyzing State Highway Maps*.
2. When students have completed the introduction have them begin the activity. Students may work in small groups or independently, depending on the number of highway maps available.
3. When students have completed the activity, discuss their answers as a class.
4. Students may complete the activity entitled *Planning an Alternative Hazardous Materials Shipment Route*. Again, they may work independently or in small groups.
5. After students have completed their activities, invite a representative for transportation of hazardous materials to discuss actual routes, procedures, safety records, etc. within your State.
6. Since answers to this activity will vary by State, no answer sheets have been provided.

**Teacher Evaluation of Learner Performance:**

Student participation in class discussion and completion of the activities will indicate

understanding.

## ROCK CHARACTERISTICS IMPORTANT IN REPOSITORY SITING

### Purpose:

This lesson will introduce students to some of the characteristics or properties that are important in repository performance: porosity, permeability, solubility, and thermal stability. Students will develop insights relating to the complexity of a geologic environment.

### Concepts:

1. Individual rock characteristics are interrelated in complex ways.
2. Measurement of one or two rock properties is not sufficient to truly characterize the rock's ability to act as a geologic repository host.

### Duration of Lesson:

One 50-minute class period

### Objectives:

As a result of participation in the lessons entitled *Rock Characteristics*, the learner will be able to:

1. define various properties of rocks;
2. discuss the complex interrelationships of individual rock characteristics;
3. explain why measurement of one or two rock characteristics is not sufficient to truly characterize a rock's ability to act as a repository host; and
4. discuss and analyze the complexity of a geologic environment and the effect this has on planning for a geologic repository.

### Skills:

Analyzing, completing, defining, discussing, drawing conclusions, explaining, matching

### Vocabulary:

Compressive strength, containment, devitrified, effective porosity, fluid, ion exchange, mineral, multiple barrier, permeability, plasticity, porosity, rock, solubility, sorptive capacity, thermal alteration, welded tuff, zeolite

### Materials:

Reading Lesson

*Rock Characteristics Important in Repository Siting*, p. SR-27

Activity Sheets

*Important Rock Characteristics*, p. 179

*Rock Characteristics Important in Repository Siting*, p. 181

Transparencies

*Rock Strata*, p. 139

Background Notes

*Rock Characteristics Important in Repository Siting Permeability, Porosity, Solubility, Thermal Stability and Sorptive Capacity*, p. 29

Videotape

*The Tuff Library* (available free of charge from the OCRWM National Information Center,  
1-800-225-6972; within Washington, DC, 202-488-6720)

### **Suggested Procedure:**

1. Before students begin the reading lesson, it may be helpful to introduce the vocabulary words and explain that they will be defined in the lesson.
2. It may be worthwhile to define a fluid and differentiate between gaseous and liquid fluids. For example, a fluid takes on the shape of its container whether that container is a coffee cup or the pore space in a rock. A gas is a fluid which will expand to fill all available space in the container, whereas a liquid, another type of fluid, will not necessarily fill the container. In the case of a nuclear waste repository, there are several "containers" to be considered.
3. A review of the definitions of a rock and a mineral may be useful. Since rocks are simply mixtures of minerals, it is more important to define a mineral. Although no two definitions will agree, a useful definition of a mineral is "*A naturally occurring, inorganically formed solid with a definitive chemical composition and an ordered atomic arrangement.*"

Looking at this definition in detail, we see that liquids and gases cannot be minerals. Manmade solids that do not occur naturally cannot be minerals. The restriction that the mineral be inorganically formed means that the solid must occur naturally outside a biological system. This excludes the solids formed by plants and animals, as part of their structure or skeleton in the non-biological environment.

4. Students should understand from the reading lesson and class discussion that the host rock can be considered a "container" because some of the properties of the rock act to restrict the movement of waste bearing fluids (e.g., porosity, permeability, and physical sorption). Those same properties also act to limit access to the wastes by outside fluids. Furthermore, the host rock, in addition to being a barrier, can act as a chemical filter (by chemical sorption/ion exchange) to selectively remove contaminants from a moving fluid.
5. The fundamental point to get across to students is that no host rock will be the ideal container or chemical filter. Strengths as a container may compensate for weaknesses as a chemical filter and vice versa.
6. Students may be interested in learning more about the methods employed by geologists who

sample, store, and study the tuff samples from Yucca Mountain. You may wish to show the videotape entitled *The Tuff Library* at this time.

**Sample Videotape Questions - *The Tuff Library***

- a.) In what type of rock will the proposed repository be mined if Yucca Mountain is chosen as the site for the Nation's first high-level nuclear waste repository?
  - b.) How is the Sample Management Facility like a library?
  - c.) How are the core samples from Yucca Mountain processed?
7. After completion of the reading lesson and discussion, assign the reading review entitled *Rock Characteristics Important in Repository Siting* and the activity entitled *Important Rock Characteristics* in which students will complete a definition-matching exercise to reinforce the reading material. Emphasize the importance each characteristic has in relation to a repository in any type of host rock.
8. Direct students to choose partners or separate into small groups. Allow approximately 10 minutes for groups to discuss their understanding of the significance of rock characteristics to the geologic repository, and draw a conclusion to be shared with their classmates.

**Teacher Evaluation of Learner Performance:**

Discussion participation and response to reading review worksheets will indicate level of student comprehension.